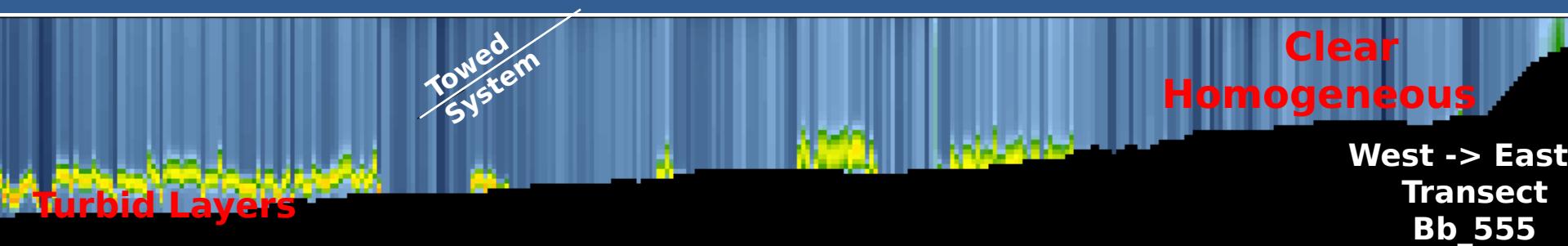




Forecasting the Ocean Optical Environment for EO Performance Surfaces

New capability to support the HM Squadron's
ASQ 24 and diver operations using
Gliders , Models and Remote Sensing



Sherwin Ladner, Robert Arnone
Ocean Processes Branch
Naval Research Laboratory



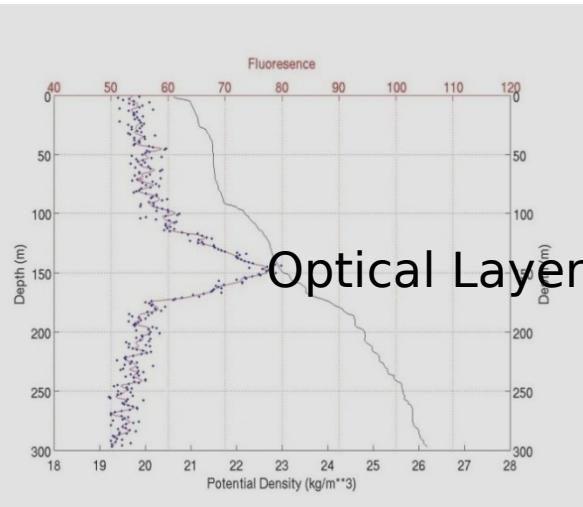
Tactical Ocean Data System (TODS) Components



- **LAGER** - Quality control of glider optical and physical properties
 - Deployment, Processing and data QC and analysis
- **OPCAST** - 2D Forecasting of Surface Optics out to 48 hours
 - Coupling Satellite optics and models
- **3DOG** - 3D Optical Volume Generator
 - Fusion of Gliders, Satellites and Models
- **Performance Surfaces** (EODES Model, Diver Visibility)
 - Linking the 3D optics with the AQS 24

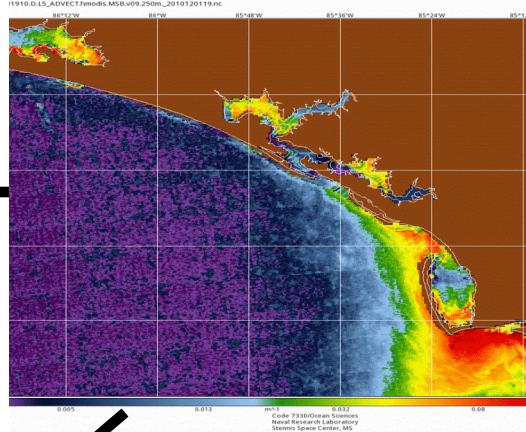
Integration of Glider Profiles, Satellite and Numerical Models to support AQS24 Operations

Vertical Optical Profiles
(Glider, BSP, etc.)

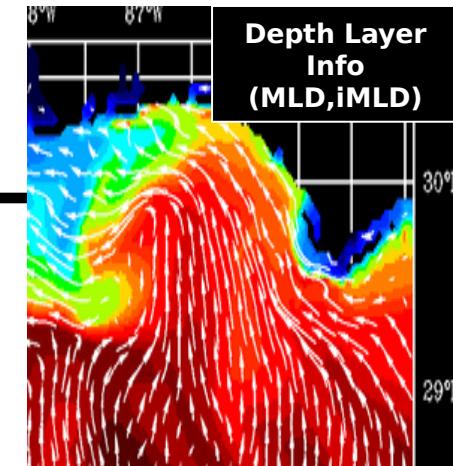


Optical Layer

Nowcast / Forecast Satellite Optics



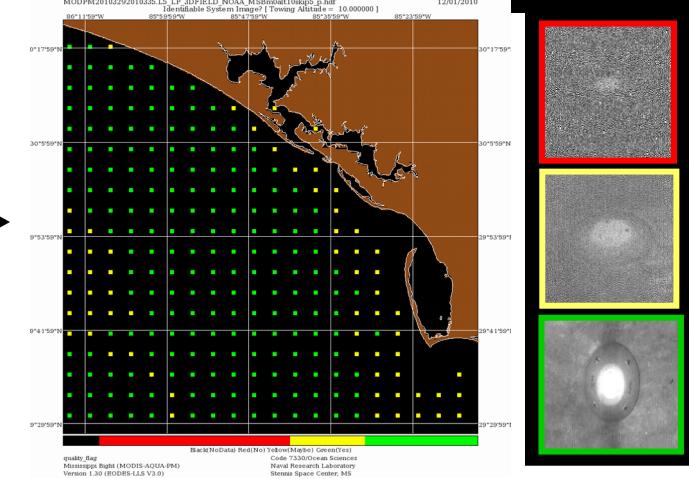
Nowcast / Forecast
Circulation Models



What Happens
Below
Satellite Surface
Today and
Tomorrow?

EODES →

Nowcast/Forecast Performance Surface
Image Quality & Optimal System Towing Altitude



3D Optical Volume & Diver Visibility



TODS Fleet Demonstration and Support

Of EO Laser Imaging Performance

Support provided to HM-14 HARP Exercise

VULCANEX 11-1 - Panama City, FL - March 30, 2011 - April 08, 2011

TODS Support (Daily Brief Provided to Fleet):

- a) Nowcast/Forecast (24,48 hours) of the Optical Environment (2D & 3D) → Impact on laser system (ASQ 24) and diver visibility
- b) Nowcast/Forecast (24,48 Hours) 3D Optical Volume / Vertical Optical Layer
- c) Nowcast/Forecast (24,48 Hours) EOIDS/AQS-24, ALMDS and diver performance surfaces
- d) Circulation models → 3Km NCOM-RELO
- e) Optical profiles collected in real-time using Slocum glider for assimilation into 3D Optical Volume (Tuning Coefficients defining the optics to physics relationship)
- f) End-to-end testing and evaluation of TODS system components (OpCast, 3DOG <- glider optics profiles, performance surfaces <- AQS-24 snippet)

Vulcanex 11-1 Coordination Planning

Mark J. Reynolds

Technical Systems Integration, Inc.

AMCM Tactics Support & Training

AMCM Weapon Systems Training School NSWC PCD

Beth Branham

Oceanographer/Test and Evaluation

Division Coordination

Kevin Oakes

Project Manager

AMCM Tactics Development

NSWC PCD, Code X32 (Tactics Branch)

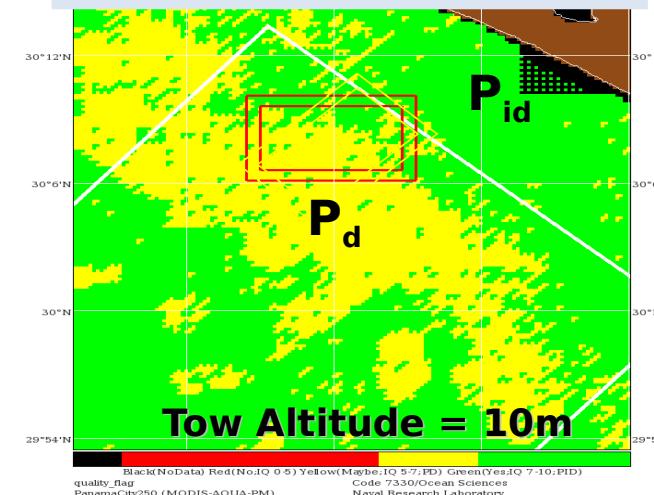
Jeffrey Willows

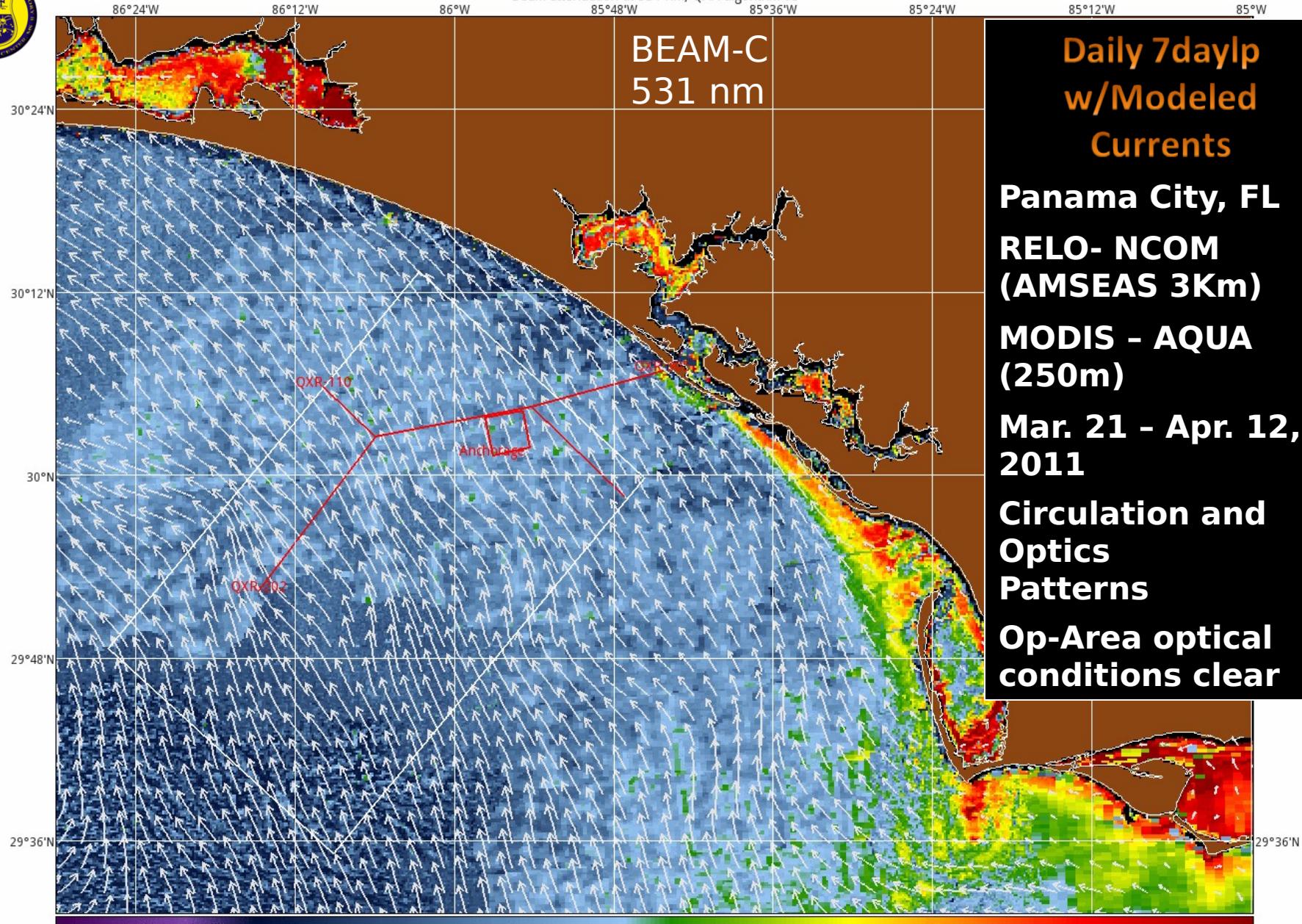
Op-Area Coordinator (Glider Activity)

Naval Support Activity

NSA PCD, N36

EOID Performance Surface





Daily 7daylp
w/Modeled
Currents

Panama City, FL

**RELO- NCOM
(AMSEAS 3Km)**

**MODIS - AQUA
(250m)**

**Mar. 21 - Apr. 12,
2011**

**Circulation and
Optics
Patterns**

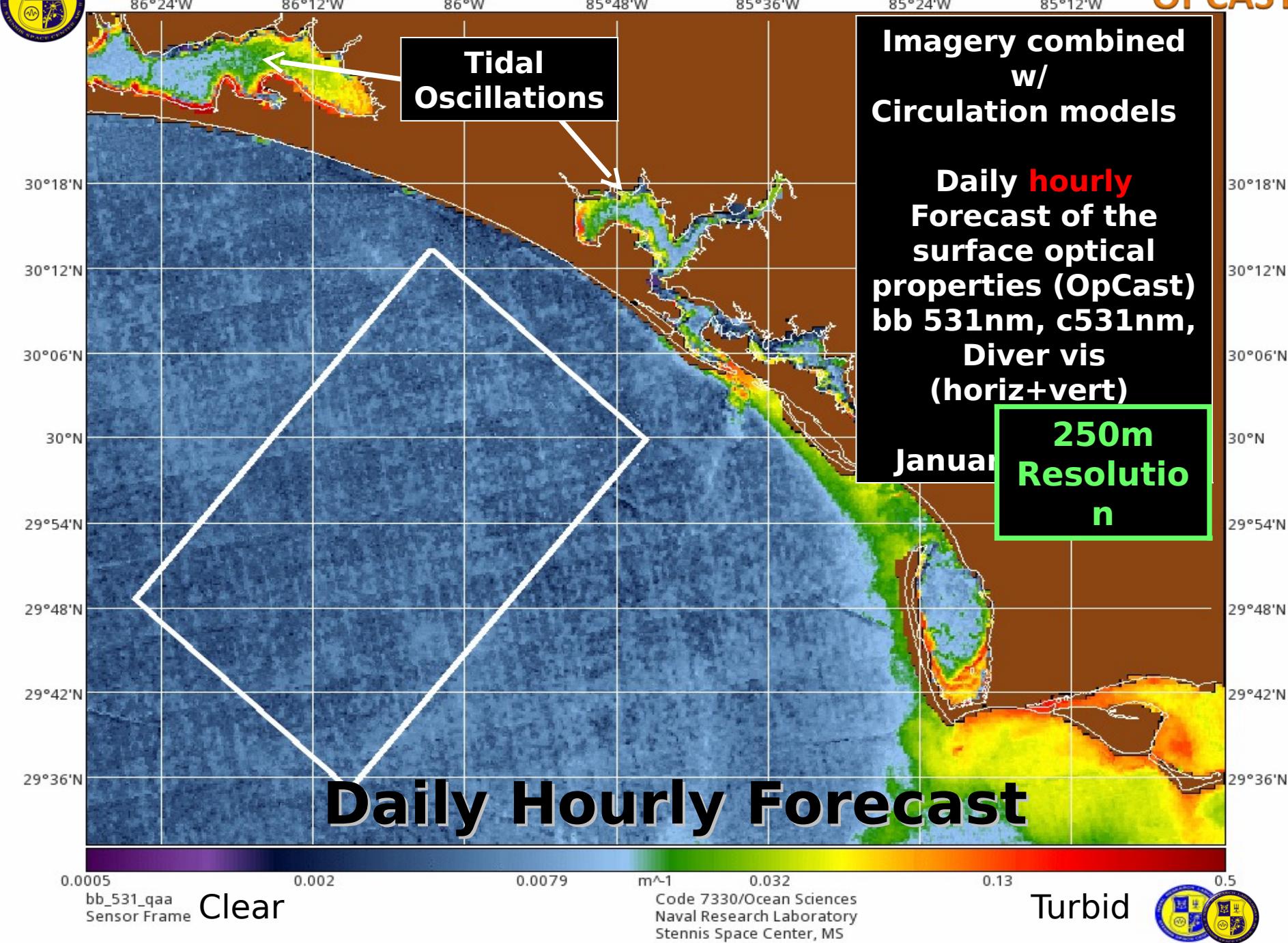
**Op-Area optical
conditions clear**





aqua.20110115.0115.184916.D.L5_ADVECT.hmodis.PAN.v08.250m._20110115184916

OPCAST



Tidal Oscillations

Imagery combined w/ Circulation models

Daily **hourly** Forecast of the surface optical properties (OpCast) bb 531nm, c531nm, Diver vis (horiz+vert)

Janua

250m
Resolutio
n

Daily Hourly Forecast

bb_531_qaa
Sensor Frame

Code 7330/Ocean Sciences
Naval Research Laboratory
Stennis Space Center, MS

Turbid



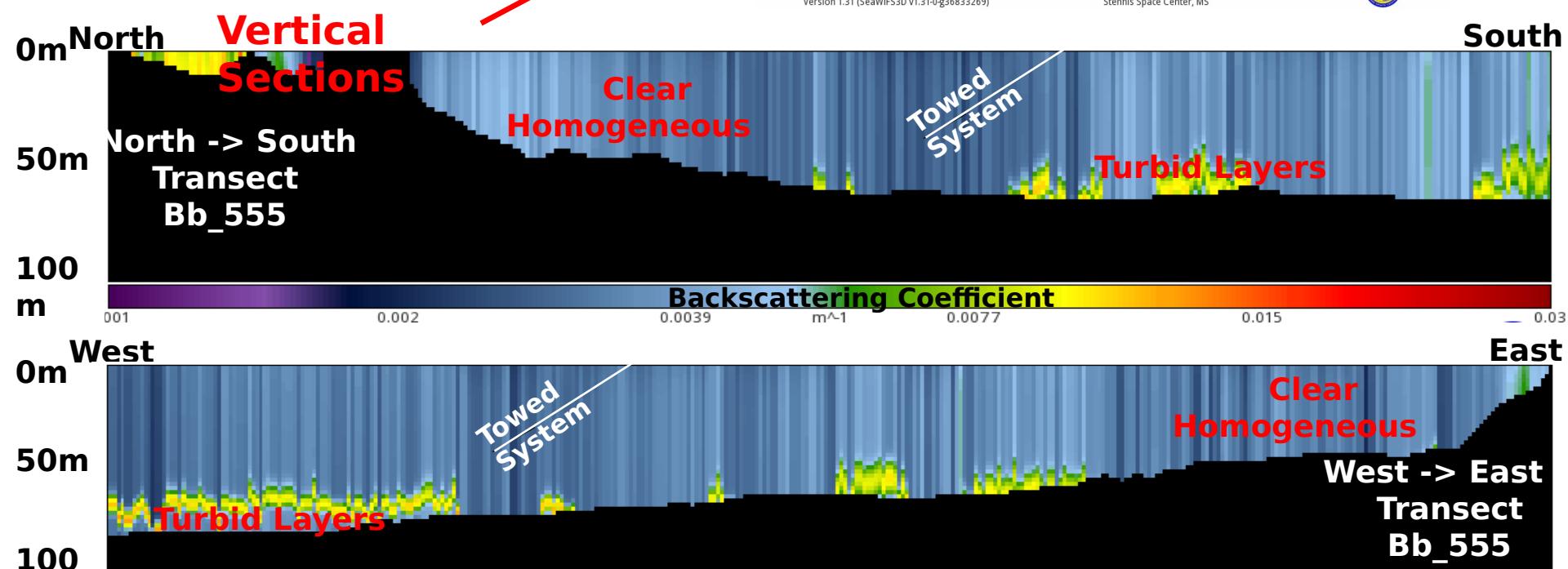
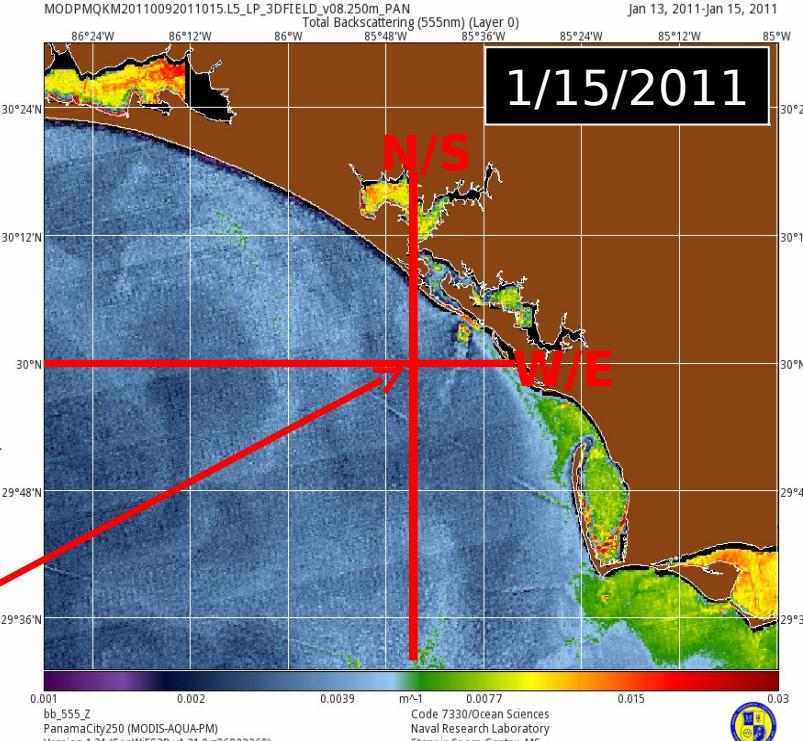


3DOG

3D Optical Generator
Merging
“Satellite, models
and
In situ data “
Surface to Bottom
Animation
(Black Areas are Bottom)

250m
Resolution
Coefficients

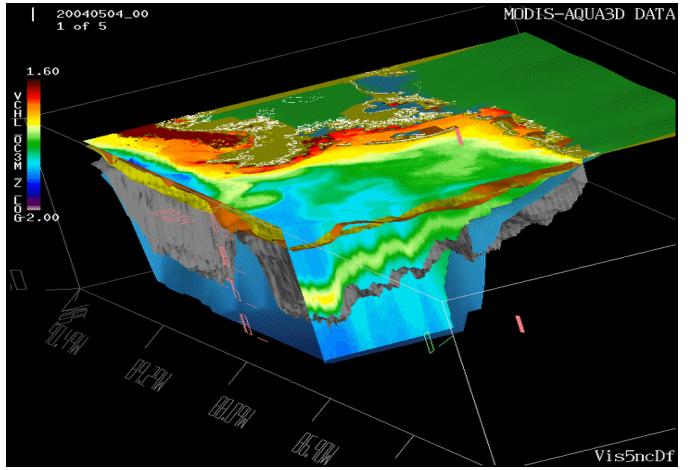
Need
Tuning
Daily
Using
Slider



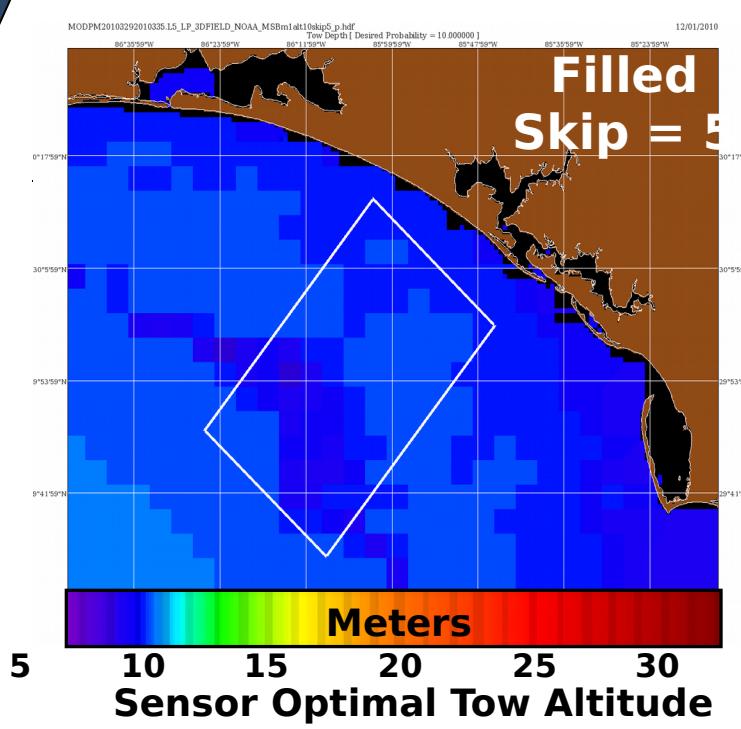
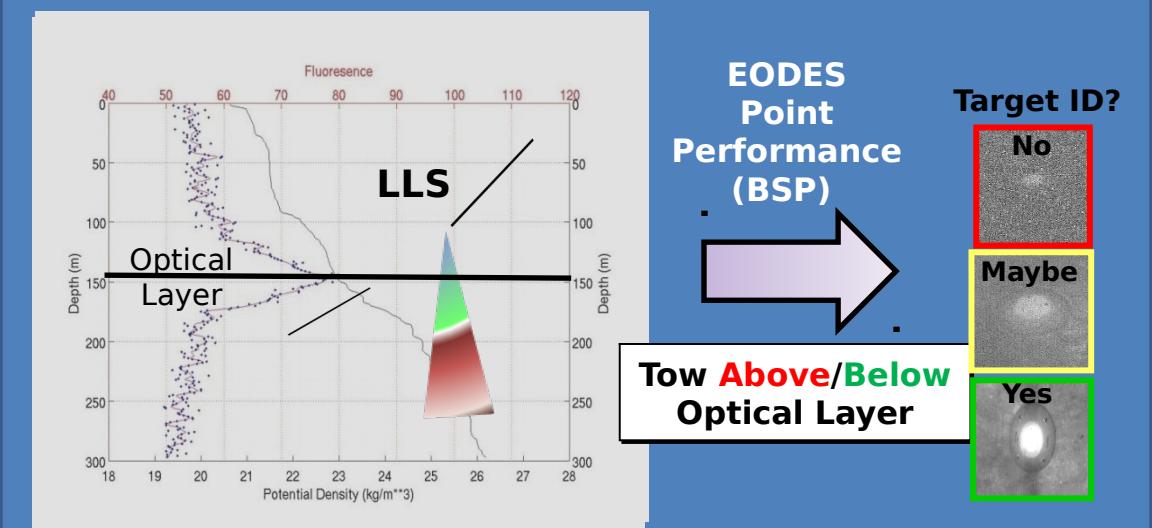
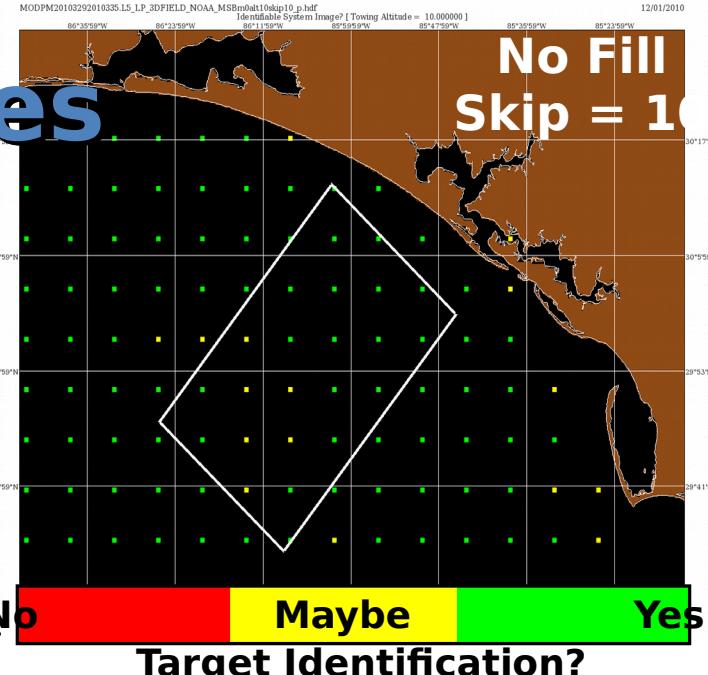


Performance Surfaces

Regional Battlespace Characterization 3d optical profiles



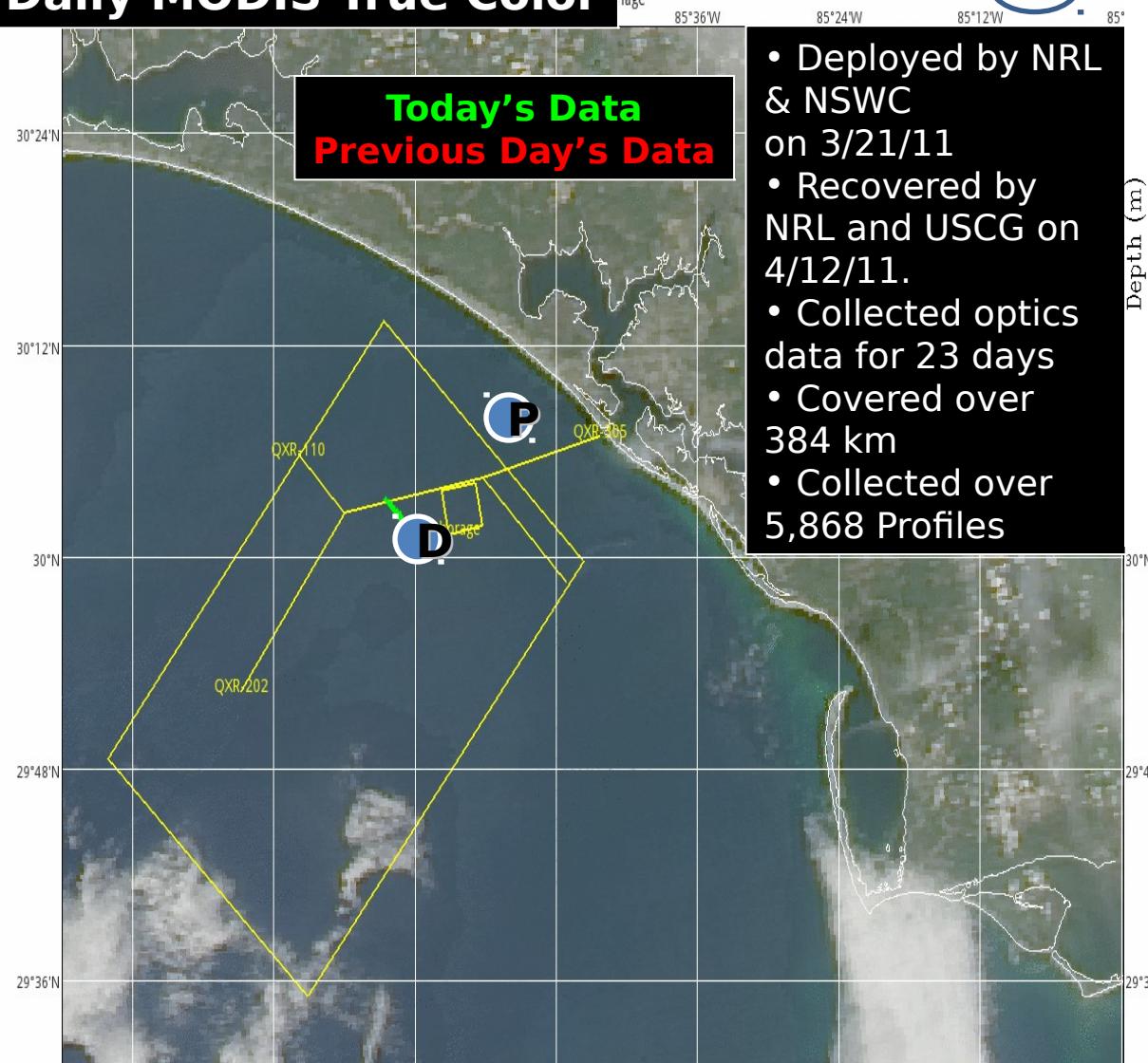
Regional laser
imaging
performance
(EODES Model)



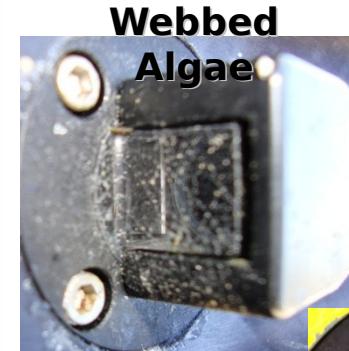
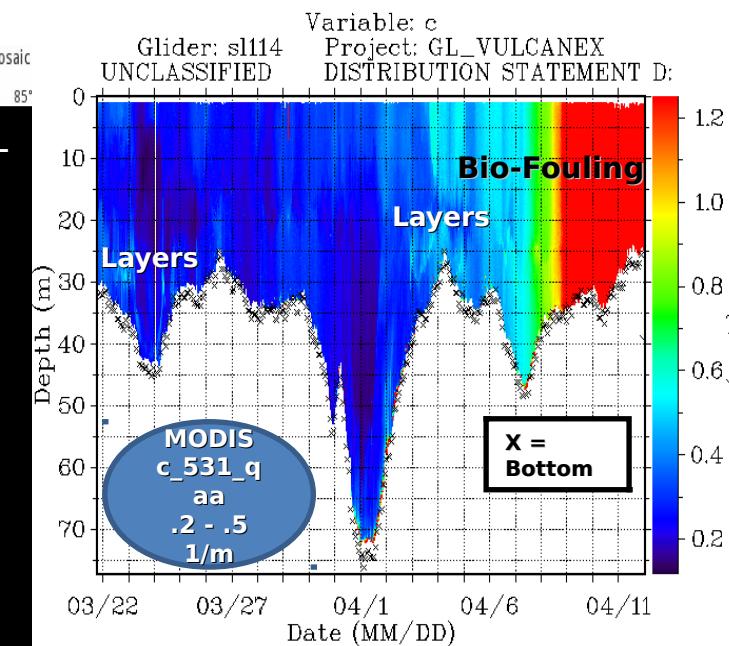


Vulcanex Glider Operations

Daily MODIS True Color



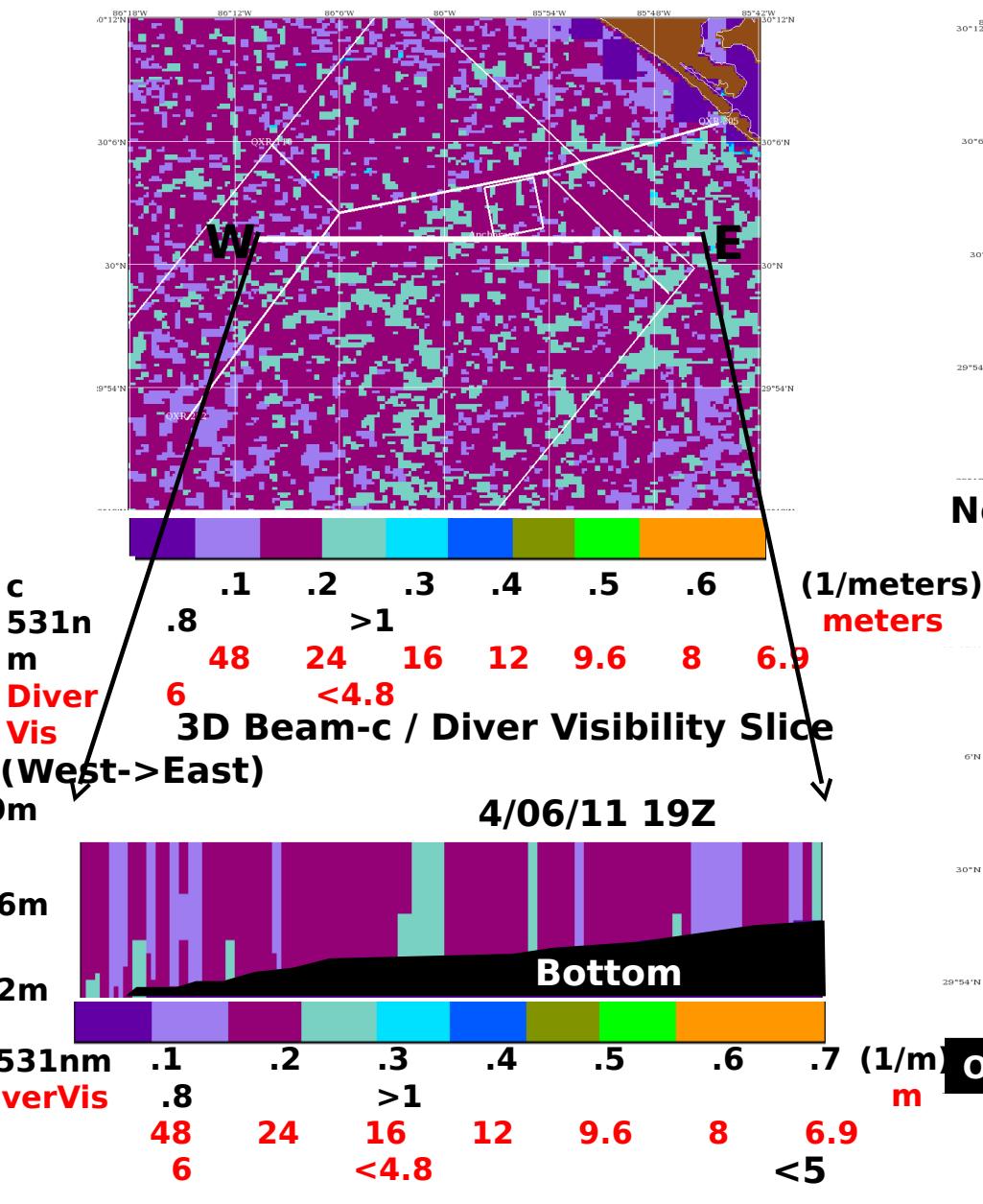
- Deployed by NRL & NSWC on 3/21/11
- Recovered by NRL and USCG on 4/12/11.
- Collected optics data for 23 days
- Covered over 384 km
- Collected over 5,868 Profiles



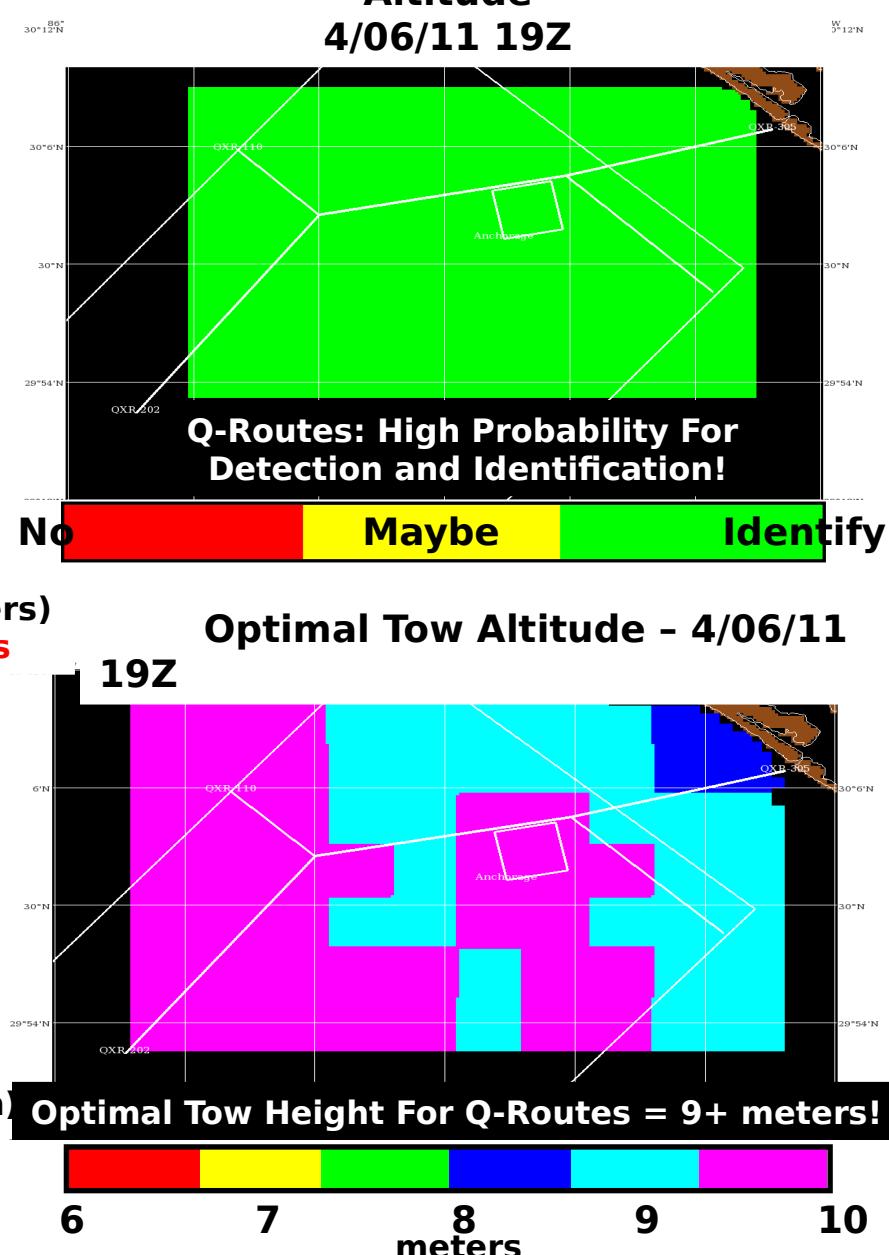


24 Exercise Support Products (Nowcast, 24 & 48 Hour Forecast)

Surface Beam-c / Diver Visibility 4/06/11 19Z



Target Identification @ 6m Tow Altitude 4/06/11 19Z

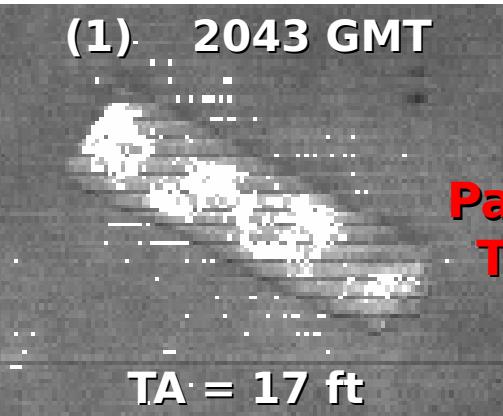




AQS-24 Snippets (4/7/11)

Step-Ups

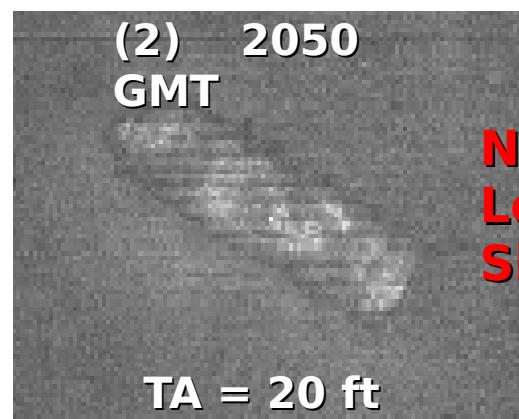
(1) 2043 GMT



TA = 17 ft

Same Object
Passed Over Multiple
Times at Increased
Tow Heights

(2) 2050
GMT

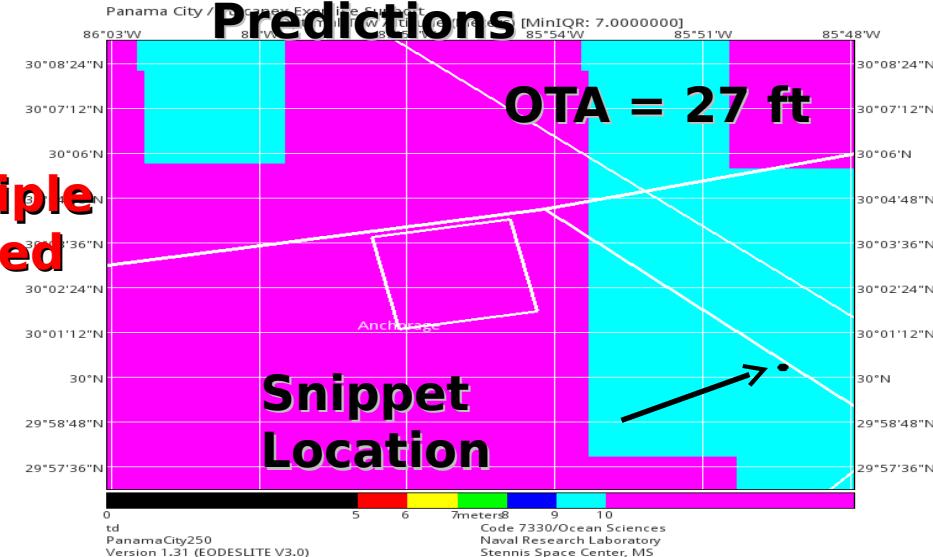


TA = 20 ft

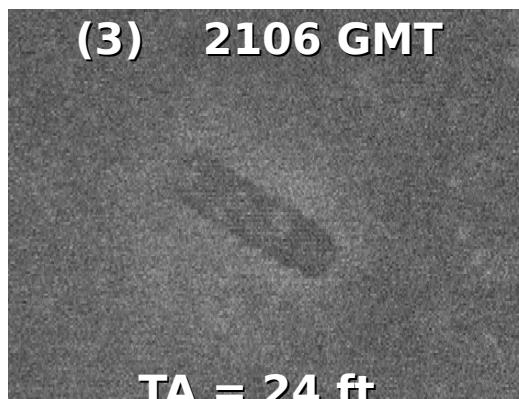
~20% Increase
in Predicted Tow
Heights = More
Efficient
Planning and
Clearance Times
with Same
Probability of

4/7/11

Performance
Predictions



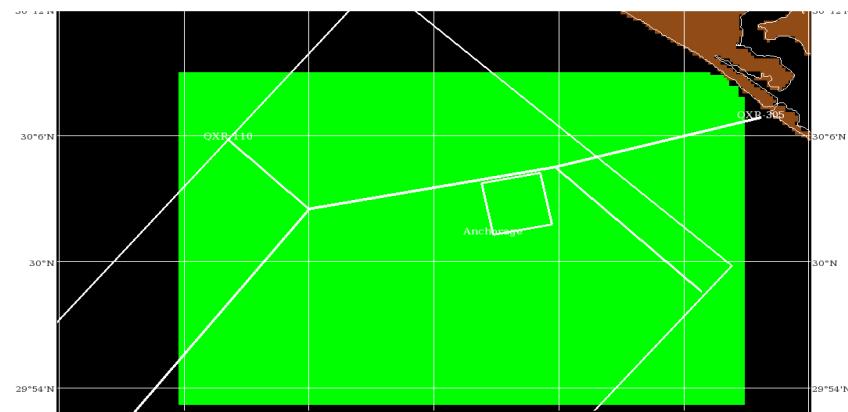
(3) 2106 GMT



TA = 24 ft

No Maybe Identify

Q-Routes: High Probability For
Detection and Identification!



Summary

HM-HARP Vulcanex 11-1 Fleet Demonstration Panama City, FL (March 30 - April 08, 2011)

- First time an ocean optical forecast provided to MCM operations
- Demonstrated capabilities of Tactical Ocean Data System (TODS) - AQS-24 Performance
 - Surfaces (Nowcast/Forecast)
- Provided daily brief of the optical environment (Nowcast/Forecast) to HM-14.
- Obtained validation data for MCM performance surfaces (glider profiles, AQS snippets, BSPs)
(100% predicted vs. actual ID for mine targets)
- Fleet Feedback:
 - Products were *crucial* to the overall assessment of the squadron's capabilities
 - Predicted optimal tow heights provided a baseline to brief pilots and air crewman prior to their missions (20% increase in predicted tow heights).
 - Correlation to post-mission BSP resulted in similar water column assessment
 - Products were user friendly and provided useful and reliable information for mission

Summary (Continued)

Impact on Warfighter:

- Option to input user defined tow height (better image quality -> IQR)
- Predicted/forecasted tow heights provide more efficient mine clearance planning and timeline with same probability of identification
- Increase in probability of detection/identification using tow heights based on predicted optical 3D environment.
- Helps UMCM dive units with re-acquisition and ID missions by providing a predicted 3D diver visibility performance surface.
- Forecasts of subsurface current velocities and direction provides important mission planning information for:
 - sweeping moored mines
 - diver deployment